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Behaviour and Daily Activities of the Japanese Pika, *Ochotona hyperborea yesoensis* [1)2)]

By

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(With 8 Text-figures and 1 Table)

Owing to their peculiar habits, involving stenotopic habitat preference, production of characteristic calls and hoarding of foodstuff for winter, the pikas have attracted attentions of many naturalists. Nevertheless, our knowledge on their ethology, sociology and ecology is still far from satisfaction. This is also true for the Japanese pika, *Ochotona (Pika) hyperborea yesoensis* Kishida, although several papers have been published on some aspects of their habits (Inukai, 1931a, 1932, Inukai and Shimakura, 1930, and Sakagami *et al.*, 1956, especially Haga, 1960). Main reasons for the lack of precise observations are their habitat preference for high altitudes or barren lands hardly accessible to research workers and the difficulty to rear them under laboratory conditions, because of their high susceptibility to pneumonia and aspergillosis.

Considering this lack of information, the author began to elucidate the ethology, sociology and ecology of the Japanese pika through field observations. The study was started in 1967 and still goes on progress. In spite of numerous difficulties, the pikas possess some habits which facilitate direct observations, being difficult in many other mammals. Their sedentary nature with relatively fixed home ranges makes continuous observations of particular individuals possible. Furthermore, in contrast to many other mammals with nocturnal habit, their auroro-crepuscular activities made in relatively open slide rock zones accompanied with frequent calls enable to make accurate audiovisual tracing of their behaviour sequence.

Following the previous report on the Himalayan pika, *O. (Ochotona) roylei* (Ogilby), the present paper deals with elementary behaviour patterns and daily activities of the Japanese pika, based upon the observations carried out from July, '68 at Oketo (alt. 500～600 m), Kitami district, the type locality of the subspecies here reported (Kishida, 1930). The results of occasional observations made at Mt. Hakuundake (1,800～1,900 m) and other mountainous ranges are also incorporated when necessary.

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1) Contribution No. 854 from the Zoological Institute, Faculty of Science, Hokkaido University, Sapporo, Japan 060

2) Studies on the genus *Ochotona* Link (Mammalia, Lagomorpha, Ochotonidae), II

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Methods: Before dealing with particular aspects of behaviour, some basic procedures necessary for observations of the behaviour of pikas are briefly mentioned here. The first approach to confirm their presence is to search at slide rock areas with piling loose rocks exposed above the ground. Their presence is usually confirmed there, either by the accumulation of characteristic globular dungs, usually beneath or between rocks, or by occasional strong shrills and weak groans. Waiting at an edge of such loose slide rock area at calm dawn or dusk, keeping the complete stillness, the pikas may appear, sooner or later, from holes or fissures of rocks, usually within one hour.

Using the binocular telescope (× 9), the pikas can be identified individually by a number of features, such as scars on fur and margins of ears, body size, characteristic hairs covering ears, tone and hue of hair coat and some other minor peculiarities. These features are often seen so differently according to the angles of view that the choice of reliable recognition marks is recommended, especially during the moulting period. The pikas have two moults, approximately one in September~October, and the other in March~May at Oketo. After moulting the previous scars on hair coat almost disappear. Even out of the moulting period, some scars are often replaced by others within one month or so. Consequently continuous observations are indispensable to keep the individual identification throughout the season. Another recognition feature, often much more useful than visual cues, is their calls. After about one month of intimate contacts with them, each individual could successfully be identified only by their calls, their peculiar tone and characteristic call types uttered occasionally.

Another important prerequisite is the choice of the favourable observation point, where the perspective for the whole slide rock area is possible and the number of pikas in activities, their musing (cf. Section Musing) and calling points are easily checked.

On the first days of observation, they are very timid, their extranidal activities are cautious. Running is short and quick, usually made only from one nest hole to another, through the shortest distance, though their sitting nearby is also frequently found. They acquire, however, a remarkable habituation for the presence of the observer after several weeks of contact. They recover normal rhythms and patterns of extranidal activities, not making escape into nest holes by shutter noises of the camera, or motions of the observer, sitting 20~30 m apart.

Habitat preference, nest range and observation station

Habitat preference: The Japanese pika has been recorded from many localities in the central mountainous part of Hokkaido (Fig. 1), mainly from Mts. Taisetsuzan, Mts. Hidaka, Mts. Ashibetsu and certain points in the mountainous outskirts in Kitami district (Haga, 1960 and Uchida, 1960), but so far not recorded in plains even in the northernmost area. Vertical distribution is also wide, ranging from 400 m at Oketo to the slide rock slopes near the summit of Mt. Asahidake, 2,290 m, in Mts. Taisetsuzan, the highest point in Hokkaido. Throughout this vertical range, their habitat preference is always clear, restricted within the slide rock areas and the vicinity (Fig. 2).

Not only the interspaces of exposed slide rocks, but also such rocks covered with thin soil layer are utilized by digging subterranean burrows. At extensive bare slide rock areas without even lichens or mosses, however, their calls sound rather more frequently from the marginal parts, where rocks are partially covered

with soil and ample plants, suggesting their preference for such parts than the central part consisted of bare slide rocks. Preference for kinds of rock is seemingly absent. Alpine exposed rocks and igneous rocks at Mts. Taisetsuzan or molens formed by glaciations in Ice Age at Mts. Hidaka are discriminately inhabited. Size of rocks is also unimportant as far as ample interspaces are provided, though accumulations of small movable rocks and unstable cliffs are avoided.

They also show a wide tolerance to the type of vegetations growing on or near slide rock areas, inhabiting either forests, both deciduous and coniferous, or

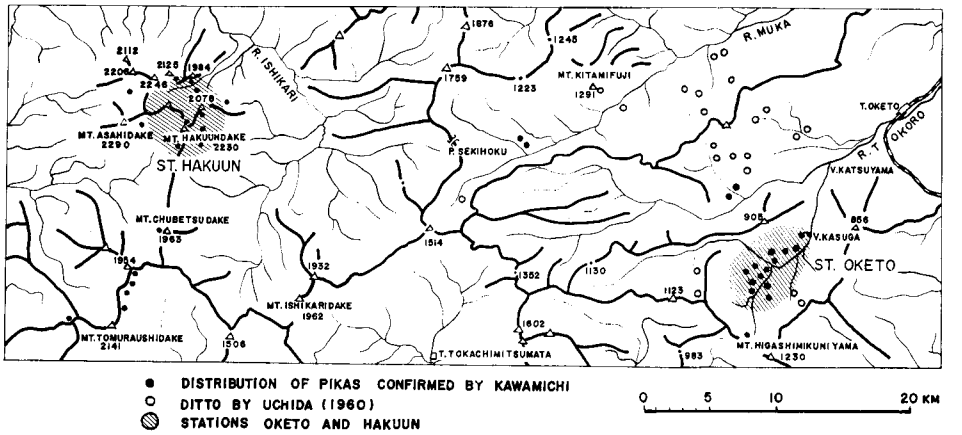

Fig. 1. Distribution of Japanese pika in Mts. Taisetsuzan and their outskirt at Kitami district, showing location of two stations.

Fig. 2. View of nest range A at St. Oketo, showing typical habitat of pika characterized by abundant slide rocks.

open fields in submountainous to alpine zones. Their presence both in humid forests and rather dry fields indicates a considerable tolerance to the humidity. For instance, they are occasionally found even in slide rock areas washed by temporary streams formed after heavy rain or snow break. Inukai (1932) and Sakagami *et al.* (1956) reported their avoidance for bamboo bush zones. But bamboo bushes usually do not grown on slide rock zones, replaced there by *Rubus* sp., *Aralia elata* Seem, etc., so that it is difficult to decide, either their absence in babmoo bushes is conditioned by vegetation or by physiography.

When some artificial constructs such as stony walls and cliffs are made near their habitats, the pikas do not hesitate to extend range into such man-made environments, as shown by the following observation.

> On 26th July, '67, the behaviour of pikas was observed at artificial stony walls and cliffs along the highway passing by the Lake Shikaribetsu (alt. 810 m), Tokachi district. The traffic of motor vehicles is frequent there from spring to autumn, for instance, 19 vehicles for 96 min. (6:12~7:48 a.m.) on that day. The author observed the passing of vehicles seven times when the pikas were outside of nest holes; four times they withdrew into nest holes, twice only hid themselves between stones and once remained indifferently, nevertheless the same individual hide itself previously. Probably they can adapt, to some degree, to various disturbances caused by traffic. It is open to the question, how they, so weak under lowland laboratory conditions, can persist to the exhaustion gas produced by vehicles. According to the experiment by Demin (1962), the exhaustion gas is 100% fatal to the Mongolian pika.

Within the limit of the information so far given by various authors, two biological groups are likely to occur within the genus *Ochotona* concerning the habitat preference, that is, rock and field dwellers as follows:

	Rock dwellers	
O. (*P.*) *h. yesoensis* Kishida	Slide rock areas (various authors)	Hokkaido
O. (*P.*) *h. mantchurica* Thomas	"At rocks and cliffs of forested mountains" (Loukashkin, 1940)	North Manchuria
O. (*P.*) *h. yoshikurai* Kishida	"In the crevices of rocks in the forest" (Inukai, 1931b)	Sakhalin
O. (*P.*) *princeps unita* Hollister	"At slide rock habitat" (Hayward, 1952)	Utah, U.S.A.
O. (*P.*) *alpina* (Pallas)	"In stone deposits both forested and open ones" (Khmelvskaya, 1961)	Altai, USSR
O. (*P.*) *pallasi pallasi* (Gray)	"Among the slide rock" (Allen, 1938)	Gobi
O. (*P.*) *rutila erythrotis* (Büchner)	"Choosing the most desolate rocky places and boulder field" (Allen, 1938)	Tibet and Kansu
O. (*O.*) *roylei* (Ogilby)	"In loose slide rock areas among open and wood lands" (Kawamichi, 1968)	Nepal
	Field dwellers	
O. (*O.*) *thibetana thibetana* (Milne-Edwards)	"Not a rock dweller, but frequents thickts and woods" (Allen, 1938)	Mainly in Szechwen

O. (*O.*) *daurica daurica* (Pallas)	"Avoid the rocky situation, burrowing in the patches of grass and weeds in the valley bottoms" (Allen, 1938)	Gobi

Summarizing, among 14 known species[1], the habitat preference is more or less known in eight species, six rock dwellers and two field dwellers. The differentiation of these two types is interesting with respect to the evolution of the genus.

The utilization of man-made constructs mentioned above could be known in the other species, in connection with increased human interference in their habitats. The strong synanthropic tendency such as the use of stony hut by natives found in *O. roylei* (Kawamichi, 1968) has, however, so far not been reported in *O. h. yesoensis* and the other species.

Structure of nest range: Within slide rock areas, various activities of pikas are performed by means of numerous natural crevices or circular holes. The circular holes, obviously less numerous than natural crevices, are usually $6 \sim 8$ cm in diameter (average 7.4 cm, $n=20$). The winter holes opening on snow cover are also circular or elliptic in shape, usually 5 cm high and 7 cm wide (average 6.5cm high and 7.3 cm wide, $n=20$) and the smallest one 5 cm high and 4.3 cm wide, apparently the critical diameter allowing the passage of one individual. The natural crevices are used by pikas with no or little elaboration by themselves, whereas the circular holes, either on soil or on snow, are their own products. For the simplicity, the author applies the term "nest holes" to the following cases: 1) Circular holes, apparently dug by pikas, even if the use was not confirmed by direct observation or by indirect evidence, 2) Natural crevices, the use of which by pikas was confirmed by direct observation. The tunnels following these openings are henceforth, called "nest burrows". Therefore, a nest hole followed by nest burrow by the definition does not necessarily mean its communication to the real subterranean "nest", not seen from the outside, that is, some nest burrows are merely interrock subways. Likewise, all entrances used in winter found on snow surface are called simply "snow holes".

The distribution and density of nest holes at Station Oketo is shown in Fig. 3, 133 openings within 15×10 m.sq. At this area, rocks are mostly covered with a thin soil layer. Consequently 56 are nest holes in circular shape opening either on soil surface or between rocks, and 77 natural crevices between rocks. The utilization of these crevices is certain, though in not all of them the use was directly observed. Some nest holes are used with high frequencies, but there is no strictly fixed usage of particular nest holes. At Station Hakuun 72 openings scattered within 10×10 m. sq. (Oct. '67). Both in these two stations, the typical slide rock areas were not chosen for observation where the presence of innumerable natural crevices made precise examination difficult.

1) Fourteen species in the world, restricted in the Holarctics among which 12 species from the Palaearctic Region followed by Ellerman and Morrison-Scott (1951) and two from the Nearctic by Hall and Kelson (1959). No species is common to both regions.

The performance of extranidal activities, frequent departure from and entry into nest holes, food intake, calling and musing, are concentrated at some particular places within the area. The pikas repeatedly go and return from one such place to another by means of nest burrows or surface pathways. These particular places are henceforth defined as "resting places", usually 2~5 m in diameter. Resting places in Fig. 3 coincide with the concentration of nest holes.

The pikas are very sedentary. The courses of extranidal movement are so fixed that several pathways between nest holes closely nearby are clearly marked on grassy or mossy ground. The daily trails of each individual shows the performance of most daily activities within a limited range and the maintenance of this tendency for months. This range is defined as "nest range" and the owner of a nest range as "occupant". The term nest range is not always synonymous to "home range", defined here as the area including all extent traversed by

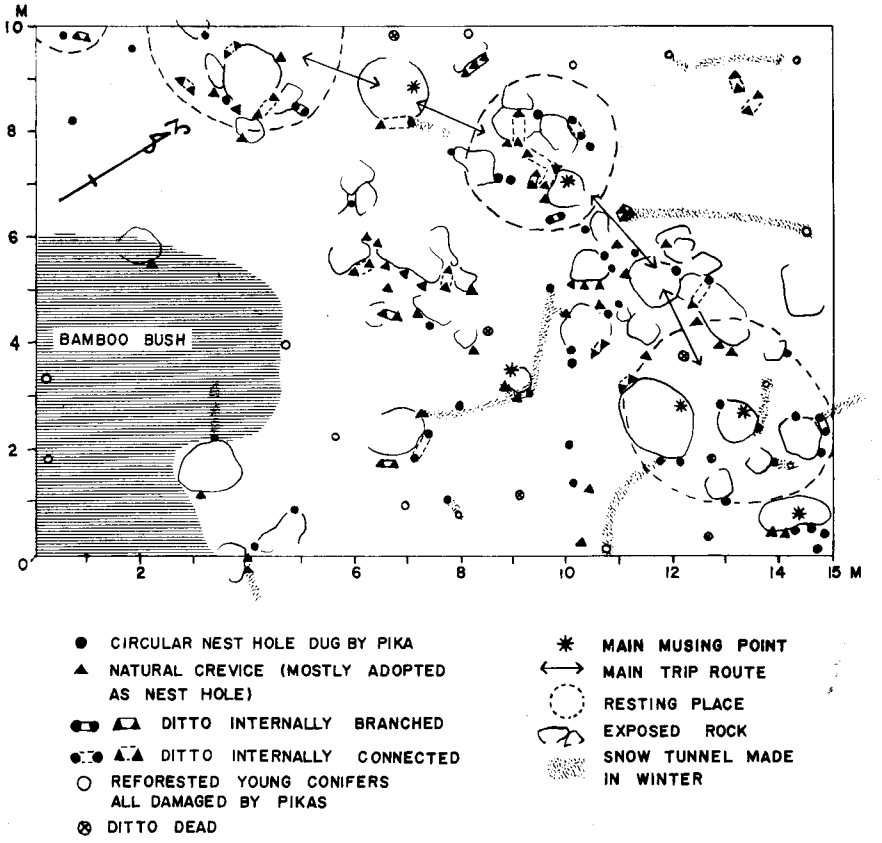

Fig. 3. Distribution of nest holes at nest range A (cf. in text and Figs. 2 and 4).

the individual concerned, is much larger, even involving the nest ranges of the neighbours. Fig. 4 shows the detail of one nest range (cf. Figs. 2 and 3), within which at least 25 resting places were determined (probably more because the part of the range was out of the limit of observation). The resting places are intimately connected to the places of defecation and food hoarding. In addition to them underground calls can be heard mostly from resting places. All these facts indicate the presence of subterranean nest beneath the resting places, although the crucial evidence is given only by removing rocks and tracing subterranean cavity system. Apart from the possible proximity to nests, resting places have important significance in their daily activities as described subsequently.

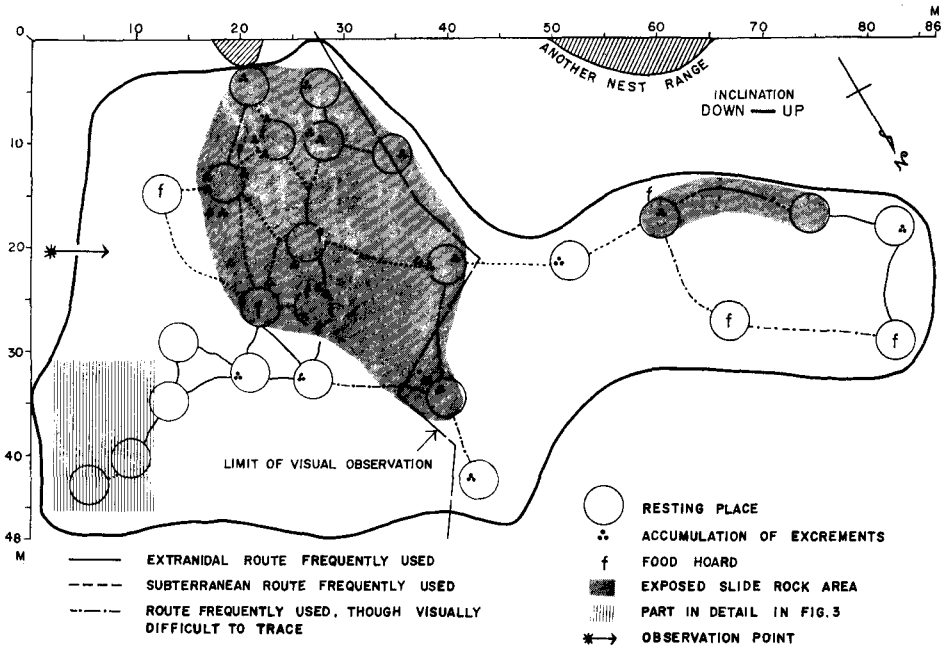

Fig. 4. Nest range A at St. Oketo.

Observation stations: In order to compare the possible difference of the mode of life, two stations were chosen at different altitudes. One in the vicinity of Oketo (500~600 m), Kitami district and the other at Mt. Hakuundake (1,800~1,900 m) within Mts. Taisetsuzan. Although two stations are remote only 47 km for each other (Fig. 1), the climatic and vegetational conditions are quite different, reflecting the altitudinal difference. Oketo is the lowest locality(the lowest habitat, 400 m) so far known of *O. h. yesoensis*, while Mt. Hakuundake (the highest points, 2,030 m) is the third highest point in Hokkaido. Most continuous observations through the year were undertaken at St. Oketo, with occasional visits to St. Hakuun in summer. Fragmentary observations were also made at some other areas, including Mt. Tomuraushidake (2,141 m), Lake Shikaribetsu (810 m), both belong-

ing to Taisetsuzan National Park, and Mt. Poroshiridake (2,052 m) in Mts. Hidaka. Main topographical and ecological conditions of the two stations are summarized in Table 1.

Table 1. Conditions of two stations at Oketo and Mt. Hakuundake

	St. Oketo	St. Hakuun
Location (Fig. 1)	Within Oketo Forest Affairs, 13km southwest of the town, 5km north of Mt. Higashimikuniyama, in the valley of R. Ukoobi	Mt.Hakuundake (highest point, 2,030m) in the central part of Mts. Taisetsuzan range, 47km apart from St. Oketo
Altitude	500~600m	1,800~1,900m
Vegetation	Coniferous forest, partly bamboo bush zone	Typical alpine meadow
Topography	Eastern slope	Eastern and southern slopes
Period observed	IV 29~V5, '68 VII 21~VIII12, '68 VIII 25~IX5, '68 IX 12~25, '68 X 16~XI 9, '68 XII 2~20, '68 I 21~31, '69 III 16~IV 13, '69 in total 140 observation days	VI 9~10, '67 VI 28~VII 10, '67 X 6~7, '67 IX 6~11, '68 in total 23 observation days
Snow cover	First snow fall on 10th Oct, '68 Laying 12th Dec.'68~late April'69 Maximum depth 61cm (on 16th Mar.'69)	First snowfall 10th Sept. '68 Surface exposed only from June to Sept., snow patches remaining through the year Maximum depth exceeding 200cm

Patterns of elementary behaviour

In spite of marked differences in morphological and biological characters, patterns of elementary behaviour in pikas do not essentially differ from those in other members of Lagomorpha, hares and rabbits. Extranidal behaviour is consisted of leaping, running, taking food and musing. The behaviour patterns of these activities are same to those already described in *O. roylei* (Kawamichi, 1968). But brief notes are given for each of them, to facilitate the understanding of subsequent sections as well as the coming papers of this serial work. A special attention is paid for "musing" which is treated in a separate section.

Locomotion: The hind legs of *Ochotona* are distinctly shorter than those of hares and rabbits. But extranidal movements are mostly made by leaping as in their larger relatives, with frequent admixture of diagonal gait. Judging from foot prints, diagonal gait is preferred when moving within snow tunnels, probably

caused by spatial limitation. Using these two ways of locomotion, they skilfully climb up big rocks and cliffs. The unstable bipedal standing, lasting one or two seconds, is made at fighting or at seeking food for higher levels. To attain much higher levels they can jump, less than 15~20 cm high.

Food intake: The pikas are euryphagous, taking almost any available vegetable matters. Feedings are usually made in sitting posture. When eating stalks or twigs, they feed them starting from root parts gradually upward. Pulling, carrying food and feeding are always done by mouth alone, never accompanied with the use of fore paws. To get leaves at higher levels, they erect with the bodies or even jump as mentioned above. When the leaves issuing near the stalks are taken, the fore paws are lightly putting on them. Occasionally awkward climbing up, usually 30~40cm high, is observed on reforested young conifer (*Pinus sylvestris* L.) of 1~2cm in diameter to get twigs and needles, accompanied with jumping and flapping by hind legs as if scratching the trunks.

Food is mainly consumed at resting places, usually within a few metres of nest holes, either on the spot, or after being carried to the shades of rocks or into nest holes. The consumption of the carried food, at least part of it, in the upper nest burrow is certain, for the remains are often left there. Feeding within subterranean burrow system is also inferred by their departures in mumbling from nest holes. Sometimes the food is carried to the main musing points. After feeding there, they go away and again return to the same spot, carrying the next food piece by mouth. This sequence can be repeated usually for several minutes, for instance, up to 12 times during 10 min. (6:18~:27 a.m. 5th Nov. '68).

Any signs of presumable dangers or unusual circumstances are enough to stop their feeding, often keeping the food in mouth. At distance more than 4 m, generally 10~15 m from the observer, they feed with caution, taking the posture ready to run into nest holes. In such case, sudden and big motions by the observer stop their feeding. Thereafter, according to the situation, they restart feeding or enter into *musing of warning type* (cf. next section), with food in mouth or giving up it. For instance, lifting of the observer's arm stopped the feeding of one particular individual. Then it began to chew the food in mouth. Second arm lifting pressed to stop chewing again. Such coincidence of arm lifting with cessation of feeding repeated four times. More definite signs of dangers or big motions such as approaches of men release the escape into one of the nearest nest holes. Feeding activities are observed during active hours at dawn and dusk, probably also at night.

"*Washing*" and *Scratching*: "Washing" is the habit to clean the face by fore paws and scratching is made by a hind paw applied to neck, ear, cheek and even nose, probably released by biting fleas and mites, which are numerous in pikas. Harvey and Rosenberg (1960) studied the apocrine gland complex situated in cheeks of *O. princeps*. They concluded that washing and scartching of cheeks might bring the apocrine secretion onto the paws, thus serving for odorous marking of their quaters. But the author has not seen such behaviour as rubbing cheeks

against rocks when they ran about their "territories" (Kilham, 1958), or reciprocal sniffing at cheeks in a mating pair (Severaid, 1953 after Harvey and Rosenberg, 1960).

Musing

In the course of various extranidal activities, the pikas often stop any movements and enter into an akinetic posture. In the previous paper on the Himalayan pika, this posture was called "musing". Considering its importance in their behaviour system, this section deals with the description of this characteristic behaviour pattern.

1) *Behaviour pattern*: The duration of musing is variable, lasting from only a few seconds to more than 10 min. At musing the pikas usually face to the lower slope of the habitat. The body is either slightly erected, showing fore paws clearly (Fig. 5, A and C) or rather lowered without exhibiting paws (Fig. 5, B). Sometimes, especially at prolonged musing lasting more than several minutes, the pikas round the body. This rounding posture has presumably the purpose of keeping body heat, for it is specially frequent at breezing on cold days or in early winter. Interestingly they often "gaze" the sun, turning the head to it. The

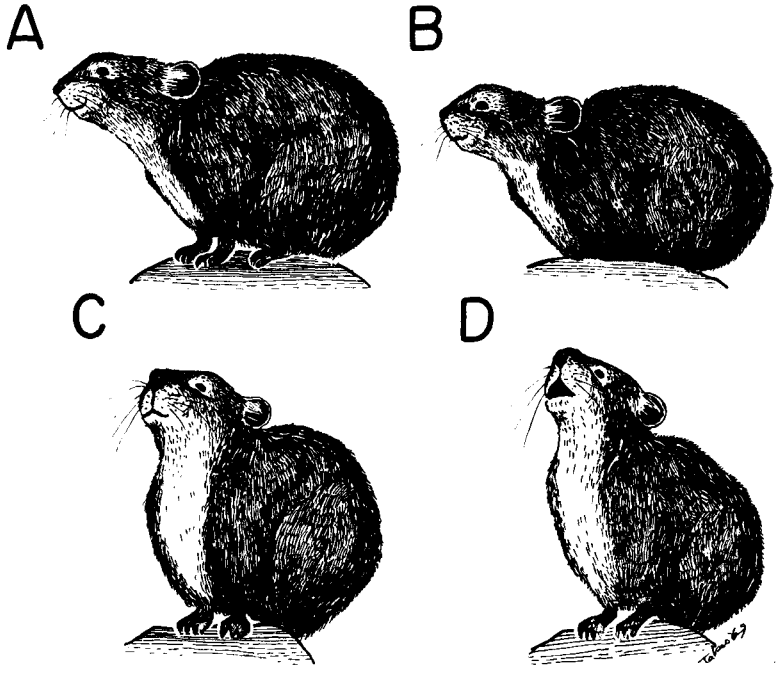

Fig. 5. Musing and calling postures. A. Showing paws; B. Not showing paws; C. As in A, frontal view; D. Calling made after taking posture C.

lifting of one fore leg at musing was rarely observed.

2) *Musing points*: Musing is made at definite points, mainly within resting places, usually higher than the surroundings, such as the tops of rocks or the fallen trees situated within a few metres, mostly less than 2 m from nest holes. Such adequate points are abundantly available at any resting place, so that each nest range has numerous musing points. Some musing points, 1～2 in each resting place, are fixedly used by particular individuals. Interestingly many musing points are used communally by more than one pika, at least by two. Owing to their elevation, musing points receive better insolation. At one section of St. Hakuun facing southward, 13 musing points observed on 8th July, '67 received sunbeams earlier at dawn and later at dusk than the surrounding areas.

Although musing is frequently seen in daily life of pikas, it is not easy to interpret its significance. Repeated observations suggest, however, the presence of at least four types, sunbathing, warning, inspection and calling out, which are quite different in function, however similar in the behavioural expression.

3) *Sunbathing type*: This type is mainly observed within two hours after sunrise and before sunset on calm and sunny day. It can be prolonged considerably, lasting usually 2～4 min., but up to 10 min. In most cases, the belly sides are turned for 1～3 times to receive heat evenly or, apparently for the same purpose, the body is rotated around hind legs as the axis, completing one rotation lasting 1～2 min. by 3～5 changes of position. Another characteristic in sunbathing musing is the absence of calls.

> A typical example is cited here from an observation on 8th July, '67, St. Hakuun, just before sunset. One individual took the musing posture for several minutes exposing the body to sunbeams. After the musing point was shaded, the pika shifted to another point still receiving sunbeams on the same rock and stayed there till the point was shaded. Then it again returned to the previous musing point frequently used to take the musing posture for further several minutes. No call was uttered during this sequence lasting for 10 min. in total.

This prolonged musing without call, accompanied by body turning or rotating are frequently observed. But sunbathing is not always made by taking such musing posture as shown by a following example.

> On 5th Aug. '68, St. Oketo, 114 min. after sunrise, one individual lay down stretching hind legs during 8 min. on a narrow rock shelf at the end of morning trip without producing calls. At first it exposed one belly side to the sun, then the opposite side, thereafter again the first side.

4) *Warning type*: This musing is characterized by a strong alert disposition directed to the invaders, either men or other pikas. The type is frequently observed when the observer is approaching to a pika, up to 4～7 m. When he stops his approach before the escape of the pika into a nest hole, the latter keeps the musing posture, even if large cries or whistles were produced by the observer. The musing continues usually for one min., occasionally up to 6 min.,

rarely accompanied by tapping of fore legs. During this musing they do not produce strong calls. But weak calls are occasionally produced, especially at prolonged musing lasting for several minutes and usually when they turn from musing to escape reaction. Their vision is relatively good. The lifting of an arm by the observer at 20 m from a pika mostly releases its immediate escape into a nearest nest hole. Of course the acoustic sense also must play an important role. By the careless approaching with loud voices and normal steps, they turn their heads to the invaders for a moment at the distance of about 10～20 m before or after entering in the musing posture.

The typical warning type musing is shown by the following observations :

Case 1 (*8th Sept. '68, St. Hakuun*): When two persons approached to a pika eargerly eating food, the latter turned the head toward them at the distance of about 20 m. Then the pika quickly climbed up on a rock, sat at the musing point so far frequently used, and took the musing posture, showing its belly side to the invaders. When the persons reached about 10 m, the pika escape into a nest hole and appeared only after they went away directing them, producing a sharp cry "Kítz" on the same musing point.

Case 2 (*30th Oct. '68, St. Oketo*): 8:56～:58 a.m. Start of observation. The observer *O*, approached to one pika *P*, taking musing posture at a musing point *a*. *P* certainly recognized the situation by turning the head to *O*, but kept the posture. At 7 m, *P* ran into a nest hole A and watched from the entrance, showing only the head. When at the distance of 6 m, the head disappeared but *P* appeared from another nest hole B, 50 cm apart from A, and again took the musing posture on another rock (point *b*). The rough motion by *O* released the entry into B. Twenty sec. later, *P* appeared from B only showing the head, then *P* returned to *b*. When *O* produced a loud cry, *P* started to run, but after a few steps, returned to *b*. The second cry by *O* caused no effect except trembling. 8:59～9:00. *P* responded to calls by other individuals, producing weak call "Kítz", then it entered in B and appeared from another nest hole C, 190 cm apart from B, taking the musing posture at another point *c*, 60 cm apart from C. 9:01. *P* produced a weak call "Pí:tz" in response to three successive calls by other individuals, still keeping musing posture at *c*.

9:02. Caused by approaching of *O*, *P* entered into C, leaving a call "Kítz-rrr".

Case 3 (*13th Sept. '68, St. Oketo*): One individual (female) Y, was artificially liberated by the author into the nest range A occupied by the other two, A[1] and B. Y made exploratory wandering throughout the range, mostly using subterranean burrow system. The occupant A approached to Y. Both Y and A took musing posture, 4.8 m apart for each other, Y directing to A, while A to the lower slope, showing the belly side to Y, as if ignoring the presence of Y. Six min. later, A approached to Y and Y left the musing point. Such reciprocal musing as ignoring the presence of the opponent with each other, was observed twice between Y and A.

In these instances, the pikas did not face directly for each other, but it is certain they recognize the presence of their opponent and are under a high social tension. Various superficially similar situations must be considered in relation to social cohesion of participants.

1) Pika A. An adult female of weight 145 g, examined by trapping on 12th Dec. '68. The occupant of nest range A (cf. Figs. 2, 4 and 6) at St. Oketo. This individual is also cited in subsequent sections.

5) *Inspection type*: This type is seen at hoarding trips. Before starting hoarding trips, pikas stand at frequently used musing points near nest holes and take a momentaneous musing for a few seconds:

> On 18th Sept. '68, St. Oketo, Pika A carried 15 pieces of grass to a hoard after each momentaneous musing. Just at the moment of carrying a 16th grass after musing, two neighbours produced noisy calls. A put the grass on the ground and ran to the same musing point about 180 cm apart. It took the musing posture, turning the head to the lower slope, not to the sources of noises, as if straining its ears. After calls ceased, A returned to carrying of the abandoned grass to the hoard.

But the musing posture before each hoarding trip is occasionally replaced by other postures: one is normal quadruped posture at these points and the other is typical inspection posture, concealing at the shade of rocks, exhibiting only heads.

The behaviour sequence described above clearly shows that here is dealt with a behaviour pattern, the significance of which is the mild warning without high psychological tension. Similar brief musing frequently seen during other extranidal activities may have the same function.

6) *Calling out type*: This is seen at reciprocal calling among individuals. The scene frequently observed is sketched as follows: One pika goes out of a nest hole, produces a strong call and takes the musing posture at the spot for a few minutes with several additional calls. In contrast to the other types of musing so far described, the body is directed towards the direction where another individual is responding.

Besides the four types of musing described above, there are some other instances which can, for the time being, difficult to classify. For example, under musing posture, food is eaten at musing points, cited at *food intake*. This might represent another type of musing. Therefore, it must be mentioned that different motivational situations are expressed by similar behaviour patterns grouped here under musing posture. In other words, various types of musing described here together are, in spite of external resemblance, different in motivations or in their functional significances. But these functions or motivations, frequently releasing by the some of four musing postures, are rarely expressed also by other postures as referred to *sunbathing* and *inspection types*.

The characteristic posture of musing has been noticed in some other species, too. The musing in *O. roylei* in Nepal was divided into two types, brief and prolonged (Kawamichi, 1968). The clear correspondence between this classification and that adopted in the present based upon functional significances will be settled elsewhere. The brief musing in Himalayan pika must include various functions. On the other hand, the prolonged musing corresponds, at least partly, to sunbathing and warning types defined in the present paper. Some other observations are cited:

O. h. mantchurica: "often climbs on the wind-fallen trees, stumps and rocks for looking over the surroundings and rests after feeding on places and warms itself for hours in sunshine" (Loukashkin, 1940).

O. princeps uinta: "perches on the top of a rock, when at rest, with the body hunched and the nose pointing slightly skyward" (Hayward, 1952).

O. rutila erythrotis: "is very cautious and when alarmed sits motionless, with its body hunched together" (Allen, 1938), similar to the warning type in the present paper.

Calls

Pikas are famous for their characteristic calls, which are very sharp, rather resembling those of some birds than of any other mammals. Leaving detailed accounts of the calls in *O. h. yesoensis* elsewhere, here are given some preliminary notes necessary to understand their general mode of life. The first call notes are produced on the eight days after birth (Haga, 1960). Thereafter any individuals can produce calls, irrespective of age and sex. The sound production follows the type in barking dogs, nearly closing the mouth after each call, although they can produce weak calls holding food in mouth. Most common calls sound "Kítz", "Kí:tz", "Kitź", "Pítz", "Pí:tz" and "Pyú:tz".[1] The strong metallic calls, like "Kítz", "Pítz" and "Pyú:tz" reach over 200 m, but weak calls are faint even at 10 m. Most calls are single-noted but often repeated, two to up to 16. In 1,000 calls heard at Station Oketo from 24th Sept. '68 to 21st Oct. '68, 705 (70.5%) were single noted, 191 (19.1%) double noted and 104 (10.4%) more than three-noted.

The calls are produced at three situations; at extranidal sitting, on extranidal locomotion and at subterranean stay, probably both at sitting and on locomotion. The calls at sitting are most frequently heard, then those from underground, calls on locomotion are most infrequent. When they call at sitting, the body is hunched (Fig. 5, D), showing a resemblance to the musing posture, but the head is directed upward and frequently kept in the same posture for a while after calling. Calling and musing are often made at the same, more or less fixed points, communally used by more than one individual. The calls produced on locomotion are mostly heard as "Kítz-rrr"', with variations such as "Kítz-r", "Kítz-rr", "Kítz-rrrr" or "Pítz-ktùr", "Py-rrr", "Pítz-r", "Pítz-rr" and "Pítz-rrr", all common in the possession of the final tone "r", which was confirmed only once at sitting. Weak cries, "Fi", "Pítz", and "Jútz" are also heard at entering into nest hole but infrequent. Underground calls produced at two situations, presumably on locomotion and at sitting. They are not differ from those produced extranidally, like "Kítz", "Kí:tz", "Pítz", "Fi", "Jútz" and "Kítz-rrr" with its variations.

The significance of various calls in *O. h. yesoensis* is still not clear. Sakagami *et al.* (1956) pointed out that calls of one individual were responded by the neighbours. Certainly some calls are responded successively by several calls, up to 16 by other individuals. Of 112 calls produced during 24 hours on 24th~25th, Sept. '68 by Pika A (cf. Figs. 6 and 7), 50 were of some communicative significance. Of

1) Obviously it is difficult to translate the call notes exactly. The same calls can sound differently among observers. For instance, Haga (1960) described, the calls in *O. h. yesoensis* as "Kichi Kichi", which correspond to coupled notes of "Kítz", "Kí:tz". or "Kitź" by the author (personal communication from Prof. Haga).

course some of these "responding calls", defined here as those produced within about five to ten seconds after any of each call note by the first individual, might be made accidentally. But the communicative nature of some, presumably most "responding calls" is obvious from the following fact: When the call by one individual is followed by those by others, the former quickly turns to the direction from which previous calls came and responds with sharp calls such as "Kítz", "Kí:tz", "Pítz", "Pí:tz" or "Pyú:tz".

Although closer anlyses of the calls are still not undertaken, production of characteristic calls are recorded in some other species. *O. h. yesoensis*, *O. h. yoshikurai* (Inukai, 1931b), *O. h. mantchurica* (Loukashkin, 1940) and *O. princeps* (Hayward, 1952) belonging to the subgenus *Pika* Lacepède and *O. daurica* (Loukashkin, 1940) to the subgenus *Ochotona* Link. On the other hand, it is noteworthy that *O.* (*O.*) *roylei*, at least in central Nepal Himalaya, produces only rare weak calls hardly noticeable at distance, never sharp calls as in the species mentioned above (Kawamichi, 1968).

Daily activities

In a previous paper, the diurnal rhythm in the activities of the Himalayan pika was described. The daily life of *O. h. yesoensis*, expressed by various behaviour patterns so far described also follows a definite rhythm as described below.

1) Diurnal activities

Pikas are active at day and night, but especially at dawn and dusk. Various extranidal activities involving food intake, calling, musing and hoarding as well as exploration of a wide range mainly appear in these periods, as morning and evening trips (Kawamichi, 1968). Fig. 6 shows the typical bimodal rhythm by Pika A within nest range A. The animal began the trip at 4:45 a.m. and ceased at 7:12 (Morning trip). It was inactive during 7:12～15:24, then became again active during 15:24～17:46 (Evening trip). This bimodal pattern was invariably seen in the seasons without snow cover at Station Oketo, and at least from early summer to autumn at Station Hakuun. However, the active hours varied from month to month, shifting parallel to the changes of sunrise and sunset.

2) Calling activities

The frequencies of audible calls were recorded at a section of Station Oketo. This section, about 250×250 m.sq. wide, was occupied by more than 22 individuals. The call frequencies were registered mainly in nine individuals, possessing nest ranges near the observation point, but the calls by other individuals, more than 13, were also included. Calls successively produced by one and the same individual were counted as one unit. This discrimination was correct for nine individuals nearby, but not in other in remote places. The successive calls produced within one minutes, coming from remote places were also inevitable counted as one unit. In spite of these defect in registration, the call frequencies for each 30 min. shows a typical bimodal pattern (Figs. 7 and 8).

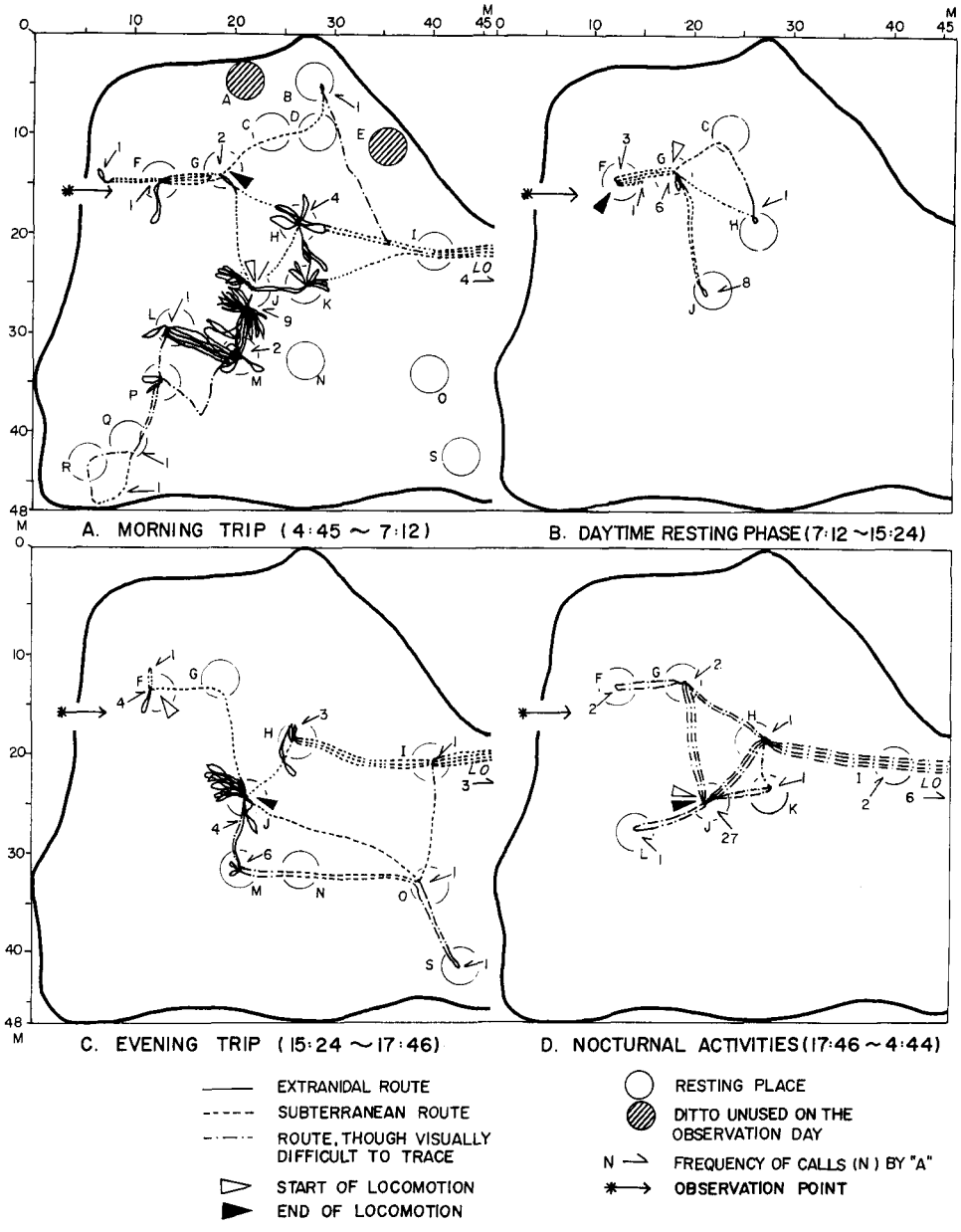

Fig. 6. A continuous 24 hrs. observation expressed in space showing a typical bimodal rhythm of Pika A at nest range A (cf. Fig. 4) on 24th~25th Sept. '68, St. Oketo.

The locomotion activity (Fig. 6) and calling activity (Fig. 7) recorded on the same day clearly synchronize for each other, each showing a clear bimodal rhythm. The difference between morning and evening trip periods was caused by the wind blown during 14:10~17:00. Active hours for morning and evening trips, defined as "morning and evening trip periods", are mostly 150~180 min. respectively.

3) Factors inhibiting activities

The bimodal rhythm both in locomotion and calls are typically observed on calm and fine day (cf. Figs. 6 and 7). On foggy or cloudy days, the calls are heard even at daytime hours, while only a few calls are heard on rainy or windy day. Fig. 8 shows the influence of various weather conditions upon the calling activity. Although a precise presentation is difficult, the same influence upon the other extranidal activities is more or less confirmed through observations.

a) Light: There is a definite negative correlation between insolation and extranidal activities. When the sun ascends higher, both calling and other extranidal activities drop, especially in summer, and increase near the sunset. On cloudy days, however, the time spent for morning and evening trips remarkably prolonges 1 to even 2 hrs. One instance is shown in Fig. 8, the morning trip period

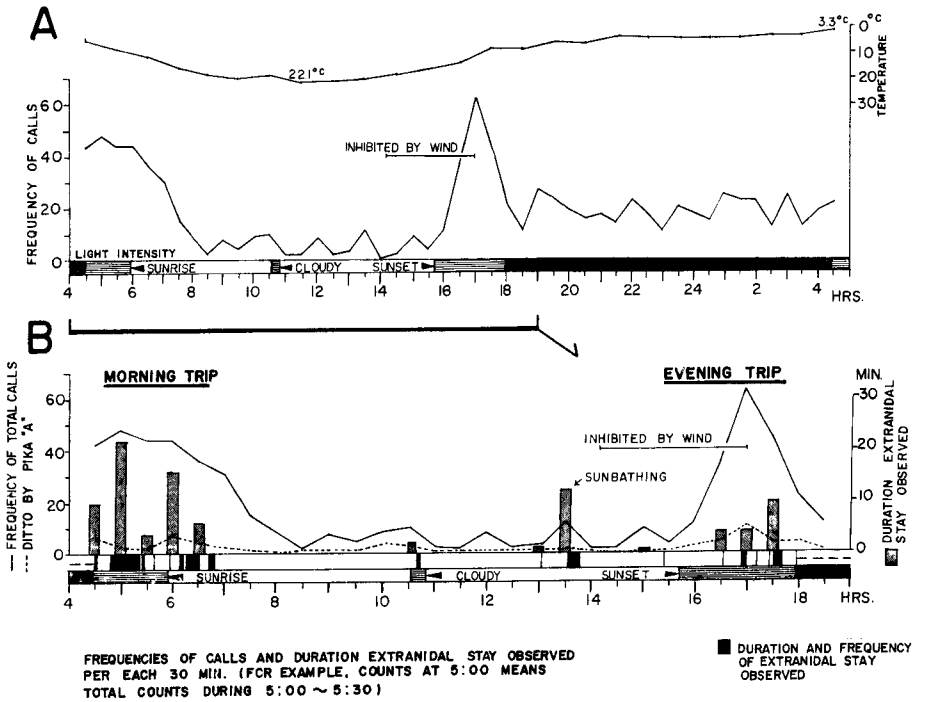

Fig. 7. The observation same to that in Fig. 6, but expressed in time, A. Total 24 hrs. sequence; B. Ditto, during 4:00~19:00.

was 3:30～ 8:30 (1st Aug. '68) against 3:30～7:30 on a calm and sunny day (28th July, '68). Thereafter, the activities gradually declined, but were still more intense than on sunny days. The evening activities also began a little earlier, namely at 15:00 against sunny days at 17:00, reaching the maximum at 18:30 and ended by 19:30. But the bimodal diurnal rhythm is still clear on cloudy days. The activities exhibited between morning and evening trip periods never reach the height as in these two periods.

b) Rain: Rainfalls, especially the heavy rains, remarkably inhibit their activities. For instance only one weak call was heard for 76 min. in morning trip period under rains on 25th Nov. '68 and no call for 30 min. in evening trip period on 24th July, '68. At the beginning of rain, extranidal movements and calling are still detected, but cease sooner or later except for occasional calls and momentaneous appearences under rain-protected rocks. During temporary pauses of rains, many pikas, 3～7, frequently produce calls in rapid succession.

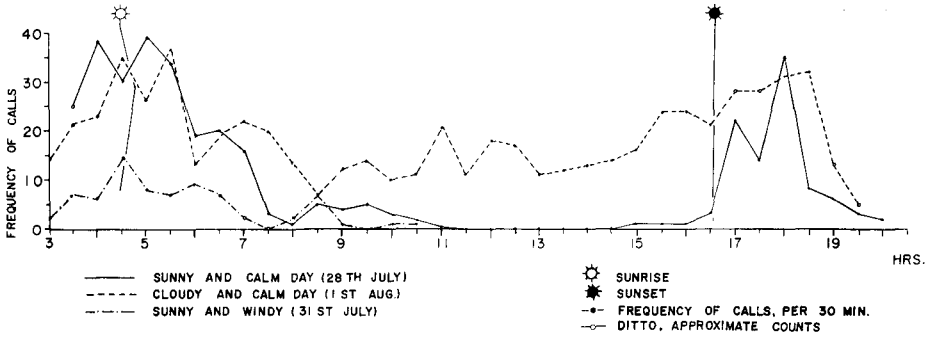

Fig. 8. Influence of weather conditions upon calling activities (all observed in 1968).

c) Wind: On windy days, their locomotion and calling activities are distinctly inhibited. A breeze of 1.5 m/sec. is clearly effective to inhibit the activities. Over 4 m/sec., the calls completely cease. The strong gust blowing periodically is sufficient to inhibit the activities even at 1.0 m/sec. No prolonged extranidal movement or lasting musing, including sunbathing and calling out types, are observed on windy days. It was frequently observed that at sudden gusts the pikas stopped locomotion and musing, followed by quick escapes into nest holes. On windy days, in spite of low extranidal activities, the bimodal rhythm of calling activity is still detected (Fig. 8). Judging from tracing of calls mainly produced from underground, subterranean locomotion is mainly confined on windy days within one more or less isolated subterranean space. The translocation which necessitates extranidal movement becomes far less intensive than on calm days.

d) Snow: The inhibition of activities by snowfall is clear, but not so remarkable as by heavy rainfall. Snow cover strongly inhibits, but does not complete stop, both extra- and intranidal activities.

Extranidal movements are markedly limited than in seasons without snow cover and performed mainly through snow tunnels. Snow tunnels are made between nest holes, or either one end of them communicates with food plants or opens on snow cover as a snow hole. The number of nest holes used in snow season is far less than in other seasons (Fig. 3). The activities observed on snow cover are calling, musing and intake of young conifers and other bare twigs.

Occasionally the pikas make extranidal locomotion on deep snow cover, traversing more than 3 m, visiting a different resting place. But the winter activities are mostly made under snow cover, using nest burrow and snow tunnels, so that the tracing of particular individuals is difficult. The bimodal rhythm of calling activity also becomes indistinct.

e) Insolation versus air temperature: The separation of the influence of these two factors is difficult. Obviously temperature is important in considering the distribution pattern of the genus, limited in north temperate to subarctic zones or in high altitudes. But as the inhibiting factors for daily activities, the influence of insolation seems to be more immediate. On cloudy days, the change of insolation by shifting clouds well synchronizes to the calls frequencies, neverthless air temperature does not markedly fluctuate.

f) Decrease of light intensity: When the obscurity spreads at dusk, all pikas stop their evening trips, staying at resting places without calls, even weak underground groans. This complete inactivity, defined as "evening rest", lasts 60～90 min., being variable among individuals. The light intensity enough to stop the trips corresponds to the obscurity between dusk and total darkness, just when the direct observation becomes impossible. But the time of evening rest is not fixed throughout the year, shifting in parallel with the change of sunset as well as of active period. After evening rest, calling activity and trips are again started, though the start of the latter is variable among individuals (Figs. 6 and 7, A).

An interesting observation was made on 12th Dec. '68 at St. Oketo. Four individuals were live-trapped between 11:00～13:40. They moved violently within traps or bit wire meshes, but became markedly quiet, when they were brought into the obscurity of a camping-tent during 120 min., all taking rounding posture with frequent face washing or sluggish erecting, putting fore paws on meshes. Thereafter they were again carried back outside at hour corresponding to the evening trip period. All of them again took violent actions as previously.

From this observation and the fact that the evening rest is inserted before nocturnal activities made at complete darkness, this inactive state is assumed to be characteristic to their daily activity rhythm, probably released by the definite rate of the change of light intensity.

Summarizing, the activities decrease in parallel with various combinations of weather conditions in the follwing descending order: calm and cloudy> calm and sunny> windy and cloudy> windy and sunny> rainy or snowy> heavily rainy; or windy and rainy or snowy.

4) Nocturnal activities

In spite of their distinctly bimodal diurnal rhythm, the activities of pikas continue throughout the night. The nocturnal activities are traced to some degree by calling notes, their tones, strength and the directions from which they are produced (Fig. 6). After the pikas take evening rests mentioned above, they again start to call and move. Details of behaviour patterns at nocturnal activities cannot exactly be determined. The performance of extranidal locomotion is confirmed by strong shrills, same to those usually produced extranidally at dawn and dusk, and by gradual shifting of such calls from one to another resting place. The hoarding is also confirmed by the sound of dragging food and the presence of food not seen on the last evening. Fig. 7, A, shows the constancy of calling activities from 19:00 p.m. to 4:00 am. The morning trip of Pika A began just at 4:44. The total amount of nocturnal movements of A is roughly comparable to that during one morning or evening trip period (Fig. 6).

The factors affecting nocturnal activities are little known. The influence of the lunnar cycle may be important, but no closer analysis has so far been made. On 30th~31st Aug. '68 at St. Oketo, the nocturnal activities remarkably increased at heavy mist.

5) Pattern of daily activities

The sequence of daily activity rhythm is variable individually as well as seasonally, but the general pattern is more or less common by as shown the following observation continuously made during 24 hrs. on 24th~25th Sept. '68 with Pika A (Figs. 6 and 7).

Morning trip:

4:40. Dim-light over the area. Start of observation.
4:45. First weak call "Kítz-rrr".
4:48. Appearance at a resting place J, with two successive calls "Kítz, Pítz" followed by responding call by another individual.
4:55. Weak call "Fi". Beginning of hoarding trips at J.
4:56~:57. Musing directing eastward. Entry into a hole with a call "Kítz-rrr".
4:59~5:02. Carrying two pieces of grass to M, intervened by a musing for several seconds.
5:03~:09. 11 hoarding trips, always with inspection type musing at J. The length of each trip being 2~7 m.
5:09. Three successive calls, followed by responding calls. Departure to L, hoarding one piece of grass there. Return to J, addition of three pieces of grass.
5:09~6:01. Taking a trip, J-L-P-Q-R-Q-P-M-J-H.
5:55. Sunrise.
6:01~:24. Active hoarding trips at H and K.
6:24~:44. Trip, K-I, then passing over the limit of visual observation (henceforth abbreviated as *LO*, cf. Fig. 4) Return and trip, G-F-G.
6:49~:51. Musing on a stump at G.
6:56~7:12. Trip, G-J-K-I. *LO*. Return and trip, B-D-C-G., though partly not observed.
7:12. End of morning trip.

Daytime resting phase:

7:51. A weak call at G.
7:51～9:03. Stay at G, with one call at 8:56. Departure to F through subterranean burrow.
9:03. One call "Pítz" at F.
9:03～10:03. Stay at F.
10:08～:42. Stay at G, confirmed by several underground calls.
10:42. Appearance at H, affected by movement of occupant B (Sun covered by cloud). Trip, H-C-J, due to counter-attack by B, using subterranean burrows, producing weak calls at each place.
10:46～13:36. Underground stay at J, confirmed by eight calls. Once appeared at 13:06.
13:36～:46. Arrival at G with call "Pítz-Pítz", followed by sunbathing musing, directing head to the valley, without calling, twice turning direction, exposing the opposite belly side to the sun.
13:46～15:24. No activity except one underground call at F.

Evening trip:

15:30～17:00. Strong wind (2.4 m/sec. at 15:30, 1.8 m/sec. at 16:41) inhibiting start of evening trip (usually about at 15:30 in September). 17:10. Complete calm.
15:24. Appearance at F. Immediate retreat after calling.
15:42. Sunset.
16:17. Start of locomotion. At first taking trip, F-J-H-I. *LO.* Return to H and trip, H-I. *LO.* Return to O and trip, O-N-M-N-O-S-O, start of hoarding at J. Carrying food to the hoard at J only seven times (In morning with 33 times) apparently caused by strong wind.
17:42. Final hoarding. Entry into a nest hole at J.
Direct visual observation impossible.

Nocturnal activities:

17:43～18:01. Four weak underground calls at J.
18:01～18:58. Evening rest at J, even without calls.
19:00. Sound of grass dragging at J, suggesting food hoarding.
19:22. One weak call at G.
19:28. Two successive calls at J means trip, J-G-J.
19:28～22:15. 10 calls at J.
22:15～:59. Trip, J-H-I. *LO.*
23:44. Return to I.
23:46. One call at H.
23:47～1:20. Stay at J.
1:20～:25. Trip, J-L-J.
2:06～:20. Trip, J-K-F-I. *LO.*
3:39. Return to J.
4:44. First visual appearance, food intake, hoarding a pecie of grass to J, shifting to M-P-Q-R-Q-P-M-J. One additional hoarding at J.

Throughout this 24 hours observation, Pika A passed all resting places within the nest range A except A and E (Fig. 6). But most time was spent at or near J,

hoarding for winter. The biggest hoard in the nest range A was found in this place (cf. next section).

Miscellaneous notes

The present paper mainly deals with elementary behaviour, leaving descriptions and discussion of more complicated behaviour systems and social organization elsewhere. Here are given, however, some preliminary notes on occupants and hoarding trait.

Occupants: The nest range A (cf. Figs. 2 and 4) was possessed by two occupants, A and B. Their co-existence of A and B was respectively adult female and male, confirmed by the examination of external genitalia (cf. also Duke, 1951). This suggests the possession of the nest range by a pair in the Japanese pika as in the Himalayan pika *O. roylei* in Nepal (Kawamichi, 1968).

Food hoarding: The hoarding for wintering is distinct in *O. h. yesoensis*. At the nest range A, Pika A made hoards most intensively in autumn. On 4th Nov. '68, in total 4320 g of half dried food masses were found separately at nine resting places (cf. Figs. 4 and 6). The weight of hoards was 1,800 g at J, 970 g at three places near K combined, 610 g at G, 150 g at H, 110 g at F, 50 g at C, and 310 g, 220 g, and 100 g at three other resting places at *LO*. The hoarding by A was noticed already in August, most intensively in September, but entirely ceased within October. Hoarding activity by B was, at least under visual tracing, far infrequent than that by A.

Concluding Remarks

The first outcome of the serial work on the Japanese pika was presented above, with special reference to the descriptions of habitat preference, nest range, patterns of elementary behaviour and diurnal rhythms of activities, which were all necessary for further etho-sociological analyses of the genus, a typical Ice Age relic. The results of most observations basically accord to those reported in the previous paper, dealing with *O. roylei*, except for the frequent production of calls. Discussion and remarks were already given in particular sections, so that here are given only two additional comments, one on nest range and the other on musing.

The bibliographical survey indicates the presence of two different ecological groups in the genus, rock dwellers and field dwellers, both *O. h. yesoensis* and *O. roylei* belonging to the former. Up to the publication of the previous paper, however, no crucial observation was made how a given habitat, say, a particular slide rock area, is utilized by the inhabiting population. The present paper confirms the result previously obtained more precisely, that is, the possession of a limited range tentatively called nest range by each individual or individuals.

Consequently the habitat occupied by a particular population is likely to form a mosaic of such individual nest ranges, which due to occasional invasions overlap one another but only partly or exceptionally. Each individual or individuals spend most of their daily life within their own nest range, which also supplies

enough daily foodstuff to the occupants, resulting in the mosaic pattern not only in space but also in life itself. Moreover, it was mentioned that one particular nest range was occupied by a pair, cited as *occupants* in last section. Such occupation of a nest range by a pair was also suggested in *O. roylei*, and though not definitely mentioned, seemingly rather a rule than an exception. If such would be the case, the spatiotemporal life pattern of the pikas approaches to the classical example of the song sparrow *Helospiza melodia*, extensively studied by Nice, in which each pair permanently possesses a definite territory, and the daily life is nearly exclusively spent within it. In the present paper, the term "territory" or even "home range" were intentionally replaced by the neutral term "nest range", in order to avoid possible confusions before detailed analyses of social structure. If the above assumption would be valid, however, the social pattern of the pikas could be summarized as the permanent or, more exactly, prolonged occupation of the nest range by a pair and the performance of most daily life within such range, a type rather uncommon im mammals. At least, this assumption could be serve as a working hypothesis, either proved or rejected by further accumulation of detailed observations.

The other comment is given as to the peculiar posture called musing. As already stressed several different functions seem to be expressed by this posture. Further analysis might clarify the minute differences in external expression among these functions, or inversely, the presence of other, still unknown functions expressed by the same or similar postures. Some of them, such as sunbathing type, are apparently relate to the self-maintenance function. On the other hand, some others, notably the calling out types, certainly appear at particular social circumstances. The restriction to the particular habitats and sedentary life in the pikas probably increased the chance of reciprocal encounters. Some of various types of musing and possibly their characteristic calls, too, might be in part outcome of the adaptation to such circumstances. In other words, some primary behaviour patterns, presumably for self-maintenance, would acquire secondary functions, with or without modification in external expression. Their auroro-crepuscular rhythm of activities, not strictly nocturnal as in many mammals, may also relate to such behavioural differentiation.

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Summary

Behaviour and daily activities of the Japanese pika, *Ochotona* (*Pika*) *hyperborea yesoensis* Kishida, endemic to the central mountains of 400～2000 m alt. in Hokkaido, were studied at Oketo (500～600 m), Kitami district, with occasional observations at Mt. Hakuundake (1,800～1,900 m). During July, '68 to April, '69, the observations were made continuously with individually recognized animals.

Their preference for slide rock areas is evident. There is no particular choice to kinds and size of rocks, as far as stable and ample interspaces are available, now to the types of vegetation covering the habitat, either forests or open fields. Each individual possesses a relatively limited "nest range" and only exceptionally leaves it. Moreover, most daily activities are performed at several particular places (resting places) within the nest range.

After brief descriptions of elementary behaviour patterns, leaping, diagonal gait, food intake, self-cleaning, etc., special attention was paid to "musing" a motionless sitting on rocks or any other spots higher than surroundings. Closer observations revealed that at least four different functions are expressed by this posture: a) sunbathing type. Especially frequent after sunrise and before sunset, often prolonged without any call, occasionally accompanied with turning and rotating body, apparently to expose the body evenly to sunbeams. b) Warning type. Characterized by strong alert disposition directed to invaders, either men or other pikas. c) Inspection type. Momentaneous musing before each hoarding trip. d) Calling out type. Taken at reciprocal calling among individuals.

The calls are produced at sitting, on running or at underground spaces, both in daytime and at night, sounding such as "Kí(:)tz", "Kitź", "Pí(:)tz", "Pitź" and "Pyú:tz", either single noted or repeated from 2, up to 16.

The bimodal diurnal rhythm is clearly recognized in extranidal activities as well as in calling. These activities remarkably increase, accompanied with long trips (morning and evening trips) at dawn and dusk, each for 2～3 hrs., while decrease at other hours. The extranidal activities are most intense on calm and cloudy days, inhibited by various combinations of weather conditions, approximately in the following descending order: windy and rainy or snowy; heavily rainy>rainy or snowy>windy and sunny>windy and cloudy>calm and sunny>calm and cloudy.

After evening trips, the activities completely cease during 60～90 min. (evening rest), followed by nocturnal activities, consisted of prolonged trips, accompanied with hoarding and calling.

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